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Excerpt from Page 258, University of California Experiment Station
Report, 1923.

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"The rapid deterioration in flavor of citrus fruit syrups during storage has been the most serious obstacle to their commercial production. J. W. Irish has determined that the rate of deterioration can be greatly retarded by increasing the density of the syrups to about 70° Balling. W. V. Cruess and J. Irish applied flash pasteurization to citrus juices and found that the keeping quality of the syrups made from then was greatly prolonged. Orange syrup made from such juice retained its flavor satisfactorily for more than twelve months".

The following footnote appears on page 258 of the Agricultural Experiment Station Report for 1923.

"Flash pasteurization was first described by Dr. E. M. Chace of the Bureau of Chemistry, United States Department of Agriculture. It consists of heating the juice to a high temperature (180 - 212° F.) for a few seconds and immediately chilling to room temperature".

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## EXPERIMENTS ON ORANGE JUICE & SYRUP

At the suggestion of the Exchange Orange By Products Company of San Dimas, the Southern California Supply Company of Los Angeles and the Sun Crush Company of Los Angeles, the writer went to Los Angeles on Sunday, April 16 to make experiments in the various factories and at the Citrus By Products Laboratory on the preparation and preservation of orange juice and orange syrup to supplement similar investigations at Berkeley. April 17-22 inclusive was spent in the work. The problems investigated are listed herewith.

1. Comparison of keeping quality of orange syrups prepared from Valencia and Navel Oranges respectively. See I.
2. Effect of sodium benzoate on flavor and color of syrup. See IX.
3. Concentration of sugar necessary to preserve orange syrup without the addition of preservatives. See IX.
4. Effect of citric acid on flavor, color and odor of orange syrup. See X.
5. Effect of salt on flavor, color and odor of syrup. See VIII.
6. Effect of exhausting air from juice under vacuum (on color, flavor, and odor) of syrup. See XXI. See also III, IV, VII, V, XXII and XI.
7. Clarification of orange juice by centrifuge and super-centrifuge. See IV and VII.
8. Use of sulfurous acid as, (a) Preservative and (b) as Preventive of darkening of color and oxidation of oil. See V.
9. Effect of aeration of juice on color, flavor and odor of syrup made from aerated juice. See XIX.
10. Comparison of methods of extracting orange juice. See VII and XII.

*11. Effect of pasteurizing juice by flash pasteurization (on keeping quality of syrup, flavor, color and odor). See V.

12. Effect of sealing orange syrup in vacuum in cans and wooden kegs.
13. Comparison of oils from different sources as flavorings for orange syrups. See XXIV.

14. Comparison of filtration and centrifuging as means of clearing orange juice. See VII and IV.

Samples of the products from the various experiments were bottled or preserved in other containers according to the nature of the experiment and were stored in Los Angeles for future reference. The samples will be examined about June 15, 1922, about Oct. 15, 1922 and perhaps about April 15, 1923; i.e. after 2, 6, and 12 months storage. Past experience has shown that definite results will be observed at the end of six months. Two months storage usually does not result in marked deterioration in flavor of orange products.

## XXI. Preliminary Test on Removal of Air from Fresh Orange Juice under Vacuum.

April 18, 1922.

#1. Juice from frost free oranges prepared as in I-1 was used.

The juice was placed in a 1000 c.c. side neck suction flask attached to a small water jet vacuum pump and vacuum gauge. The flask was evacuated to 28½ inches vacuum. Bubbles of air were given off from the juice and vigorous frothing occurred. Evolution of gas continued for six minutes at 20° C.

Samples of the benzoated juice were preserved.

#2. The juice in this test was heated to 45° C. before placing it under vacuum treatment. Evolution of gas was more violent than in #1 and the juice boiled vigorously for two to three minutes. Evolution of gas (air?) ceased after four minutes treatment. This indicated that warming the juice considerably increases the rate of evolution of dissolved air. Samples reserved.

#3. Syrup prepared as in I-1 was placed under vacuum as in XXI-1 at room temperature (20° C.). Fifteen minutes at 28½" vacuum was required to remove all of the dissolved air that could be removed at this degree of vacuum.

Therefore, it appears that syrup requires nearly three times as long as exposure to vacuum as does juice, for removal of dissolved air.

#4. Syrup treated as in #3 but heated to 105°F. before applying vacuum. Sample boiled at 28½-29" vacuum. Evolution of gas ceased after five minutes under vacuum. This result indicates that syrup should be treated before vacuumizing.

It was noted that during vacuum treatment of syrup most of the undissolved oil disappeared either by distillation or by going into solution in the syrup. Syrup after treatment was clearer than untreated syrup, probably because of removal of air bubbles.

## III. Vacuum Treatment of Valencia Juice.

Valencia oranges free from frost injury were cut in half and the juice was extracted by a Blessing Spindle. The juice was strained through a brass screen and cheese cloth and was filtered through wood pulp. The filtered juice was free from visible pulp particles but slightly cloudy. The juice was treated as noted below and samples retained of each lot.

#1 - a. Juice prepared as above made into syrup.

Sugar 12 lbs. per gallon.
Blend 3 oz. " "
Benzoate 1/10 of 1%.
Not vacuum treated.

2 - a. Juice treated in suction flask under 28½ inches vacuum for 15 minutes and made into syrup as in 1 - a. Syrup not vacuum treated.

3 - a. Same treatment as 2 - a. but syrup also treated under vacuum for 15 minutes, i.e. until evolution of air from the syrup ceased.

4 - a. Same as 3 - a but color 4 oz. per gallon of syrup was added.

5 - a. Same as #1 but color added, 4 oz. per gallon of syrup.

## VII. Experiments at San Dimas on Vacuum Treatment and Clarification of Orange Juice.

Cull Valencia oranges from packing houses near San Dimas and containing a large proportion of frosted fruit were passed through a water separator twice to remove all frosted fruit. Only the sound fruit was used for preparation of the juice used in the following tests.

### Description of Usual Treatment of Fruit.

The juice was extracted by means of a Becker orange pressing machine. This consists of two fluted bronze rollers each about 2' in diameter and about 5' long. One roller is placed above the other and the fruit passes through the rolls horizontally. The rolls remove both juice and oil.

On unfrosted fruit a yield of about 100 gallons of juice per ton was obtained on April 20. With frosted fruit the yield is 50 gallons or less.

The juice contains considerable pulp but most of this is removed by straining through an aluminum screen. The screening device consists of an inclined cast aluminum trough with perforated bottom. The pulp and juice are carried upward from the rolls through the screening trough. The juice flows through perforated bottom of the screen and the pulp is carried to a steam oil still.

The screened juice is normally carried by gravity to two large De Laval scream separators which skim off the oil (called "cold press oil") and remove some of the sediment. In our experiments some of the juice was centrifuged and some was taken direct from the rolls after screening. The fruit used in our experiments was practically free of frost injury. It was Valencia variety.

The pomace from the rolls is passed through a large meat grinder and from the meat grinder to a continuous steam still. This consists of an inclined bronze (or brass) pipe about 10" in diameter and about 30' long. The pulp is conveyed upward through this pipe; steam is admitted in numerous jets to the lower side of the pipe. Oil and steam pass out the end of the pipe to a large worm condenser and the oil is separated from the water in the receiving tank.

A series of large pipes heated by gas flames and equipped with screw conveyors are stationed beyond the oil still and can be used for reducing the pomace to a char or to ashes if desired. This was not in use on April 20.

The distilled oil is combined with the cold press oil and sold to the W. J. Bush Co. of San Diego in large steel drums (110 gals. each). It was stated by the chemist in charge that distilled oil should not be mixed with cold press oil because of the marked tendency of the former to become "turpentiny" in odor and flavor.

(Continued)

At present over 50 tons of fruit is being pressed per day. Most of the fruit is discarded, although a small quantity is converted into vinegar. This is done by permitting the juice to undergo fermentation with compressed yeast followed by settling, clearing and acetifying in large upright generators. These generators are about 6' in diameter and about 16' high. They are operated at 105-110°F. as compared with 85-90°F. in most vinegar factories. The vinegar is filtered after aging and is then pasteurized in a continuous pasteurizer and bottled or barreled.

Juice direct from screen; not treated in De Laval centrifuge.
VII. 1-a Benzoate 1/10 of 1% added.

When made into syrup, a large amount of pulp accumulated at the surface and the syrup was too cloudy for bottling purposes. Flavor excellent. Apparently contains as much oil as orange syrup towhich "blend" has been added.

2-a Juice cintrifuged in De Laval so adjusted as to remove practically all pulp. The centrifuged juice was placed at once in a 500 gallon glass lined vacuum pan and subjected to a vacuum of 24-25" for 22 minutes.

A five gallon keg of this juice was taken tothe syrup factory in Los Angeles and made into syrup as outlined in 15-a. Syrup not quite clear enough for bottlers' use. The juice contained 1/10% of benzoate.

3-a Same as 2-a but not vacuum treated. See 15-a, b & c for syrup.

4-a Same juice as 2-a but made into syrup at once. The syrup was vacuum treated at 27" for 20 minutes and taken to Los Angeles factory. When placed under a vacuum in Los Angeles 24 hours later very little air was given off by the syrup, indicating that the syrup dissolves air very slowly.

5-a Vacuum treated juice from 2-a made into syrup and syrup not vacuum treated. (samples lost by breaking of bottle).

6-a Vacuum treated juice from 2-a made into syrup at once and syrup vacuum treated at 27" vacuum for 22 minutes as in 2-a.

6-a-1 Syrup from 6-a plus blend 3 oz. per gallon. Six samples in 7oz. bottles.

6-a-2 Same as 6-a-1 but syrup placed under vacuum after addition of blend. Does not give off any air under vacuum. Six samples in 7 oz. bottles.

7-a-1 Juice through De Laval to remove pulp and oil. Made into syrup of 63° Balling at once. Neither syrup nor juice vacuum treated. Six samples in 7 oz. bottles reserved.

(Continued)

7-a-2 Screened juice from rolls not through De Laval centrifuge. Made into syrup.

Sugar 12 lbs. per gallon
Blend 3 oz. " "
Benzoate 1/10%

Not vacuum treated.

8-a Same as 7-a-2 but syrup vacuum treated at $28\frac{1}{2}$" vacuum for 30 minutes. Six bottles.

9-a Screened juice from rolls not through De Laval centrifuge.

Sugar 12 lbs. per gallon
Benzoate 1/10%
No blend or color
Six bottles

10-a Same as 9-a but syrup vacuum treated for 15 minutes at $28\frac{1}{2}$". All air removed by this treatment. Six bottles.

11-a Juice from rolls, screened and through De Laval. Juice was then taken to Los Angeles and passed through a large hand power Sharples Clarifier borrowed from the Sharples Company of Los Angeles. The Sharpless Clarifier gave a juice equal in clearness to that filtered twice through wood pulp and apparently clear enough for preparation of bottlers syrup. The Sharples Clarifier was operated at 17,000 R.P.M. The bowl was about $2\frac{1}{2}$ " in diameter inside.

The clarified juice was made into syrup by the addition of 12 lbs. sugar per gallon, 3 oz. blend per gal. of syrup and 1/10% of benzoate. Syrup not vacuum treated. Syrup apparently clear enough for bottlers' use. Six bottles.

12-a Same as 11-a but syrup vacuum treated for 20 minutes. Six bottles.

13-a Same as 11-a but color also added. Neither syrup nor juice vacuum treated. Six bottles.

14-a Same as 13-a but syrup vacuum treated for 20 minutes. Six bottles.

15-a Juice from 3-a made into syrup by addition of sugar 12 lbs. per gallon, blend 3 oz. per gallon of syrup and benzoate 1/10%. Neither juice nor syrup vacuum treated. Juice through De Laval only, not through Sharpless centrifuge. Six bottles.

16-a Same as 15-a but syrup vacuum treated for 20 minutes. Six bottles.

17-a Same as 15-a but color also added. Neither syrup nor juice vacuum treated. Six bottles.

## Note on Sealing Syrup in Plain Tin in Vacuum Preliminary Test.

Syrup containing color, blend and benzoate (1/10%) was sealed in plain tin one pound coffee cans under 27" vacuum about March 20 and stored at about 105° F. Similar syrup containing no color or blend was sealed in similar fashion in one pound coffee cans in vacuum on the same date and stored as above.

April 20.

The syrup containing color and blend has badly corroded the cans and the color has turned brown.

That containing no color or blend was in excellent condition. No darkening of color and no apparent action on the tin plate.

Note: The syrups were not vacuum treated before placing them in the cans. They therefore contained large amounts of air in solution, a fact which may account for the action on the tin plate.

Conclusions: No definite conclusions can be drawn until the various samples prepared above have been stored for at least two months. The writer expects to go to Los Angeles on June 15 to make observations on the samples and will report progress of the experiments at that time.